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(54) Title: FACE MASK FILTRATION MEDIA WITH IMPROVED BREATHABILITY

(57) Abstract: An improved face mask filtration media includes a meltblown polymer/pulp coform web formed of a matrix of meltblown polypropylene fibers with individual pulp fibers disposed throughout. The meltblown polypropylene fibers may be formed from a polymer blend having an electret additive to improve electret filtering characteristics of the polymer fibers. The invention also contemplates any style or configuration of face mask utilizing the improved filtration media.

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TITLE OF THE INVENTION

FACE MASK FILTRATION MEDIA WITH IMPROVED BREATHABILITY

FIELD OF THE INVENTION

The present invention relates to faces masks in general, and more particularly to an improved filtration media for faces masks.

BACKGROUND

Wearing protective face masks of various configurations has become standard procedure in the health care and other related fields. The use of a face mask is important to protect both the patient and the health care practitioner. In addition, many industrial applications also require wearing protective face masks to reduce dust particles and other contaminants in the air as well as to protect workers from possibly hazardous chemicals and/or bacteria.

A vast array of face mask configurations are know to those skilled in the art. Exemplary faces masks are described and shown, for example, in the following U.S. patents: 4,802,473; 4,969,457; 5,322,061; 5,383,450; 5,553,608; 5,020,533; and 5,813,398.

An important concern with any of the various face masks is to provide comfortable, low cost, and effective filtering and protection. Materials are known and available to allow the free passage of air through the body of the face mask for breathing and to prevent the passage of bacteria, aerosols, and other liquid or particulate contaminants. Conventional face masks are typically formed of multiple layers, including an inner layer and a generally coextensive outer layer. One or more filtration layers are typically disposed between the inner and outer layers.

A number of materials are known in the art for use as a barrier or filtration layer in face masks. For example, meltblown nonwoven webs are known to provide excellent liquid and particulate filtration properties. The meltblown web can be formed using any of various

polymer fiber forming materials know to those in the art, including polypropylene, polyester, and the like.

The breathability of a face mask is a factor of the pressure drop across the mask and is dictated primarily by the permeability of the filtration media. Industry standards typically require a pressure drop of 1.5 to 2.0 (millimeters of water) across the filtration media, and about 2.0 to 4.0 across the complete mask. Reduction of the size (diameter) of the meltblown fibers will tend to increase the filtration efficiency of the filter material, but also results in a tighter or denser packing of the web in general and a corresponding increase in the pressure drop across the material. Excessive pressure drops, however, make the mask difficult to breath through and uncomfortable to the wearer.

It is known in the art that the use of electrostatic fibers can improve particle removal efficiency of a meltblown web without affecting pressure drop or filter life. Reference is made, for example, to U.S. Patent No. 5,350,620 which describes a filtration material comprising a web of meltblown fibers and staple, electrically charged fibers randomly dispersed among the meltblown fibers. Generally, the filter fibers are subjected to a surface treatment to increase their electrostatic charge or polar nature. The polymer fibers are "electrified" to make an "electret" or to possess and "electret surface." The electret fibers may be produced at various stages of forming the filter media. The fibers may be treated during or after their formation, or the treatment may be carried out during or after the actual web formation. Such treatment is conventionally done by a procedure involving rubbing or corona charge treatment. Other techniques are described in U.S. Patent Nos. 4,375,718; 4,588,537, and 4,592,815.

U.S. patent No. 5,780,153 describes an electret-like filtration web made of ionomer copolymer fibers possessing electret-like surface characteristics without deliberate post-charge treatment of the fibers or web. The '153 patent also describes an improved filtration web formed

of blends of either polypropylene or polyethylene and 20% to 50% of the ionomer resin.

The art is continuously seeking to improve filtration media used particularly in face masks without adversely affecting the breathability or comfort of the masks. The present invention provides such an improvement.

SUMMARY OF THE INVENTION

Objects and advantages of the invention are set forth in part in the following description, or may be obvious from the description, or may be learned through practice of the invention.

The invention provides an improved face mask filtration media, and an improved face mask incorporating the filtration media. The style or configuration of the face mask is not particularly important. The filtration media according to the present invention can be utilized in any face mask configuration requiring a filtration layer or media. Such masks generally include a body configured to fit over the nose and mouth of the wearer, and at least one layer of filtration media disposed between an inner layer and an outer layer.

The filtration media is a meltblown polymer/pulp coform web formed of a matrix of meltblown polymer fibers with individual pulp fibers disposed throughout. It should be understood that the invention is not limited to any particular polymer. A polypropylene based polymer is particularly well suited for face mask applications. The coform web may contain about 2% to about 50% by weight of the pulp fibers. The pulp fibers engage and hold the polymer fibers apart and thus add significantly to an increase in permeability of the web without affecting filtration characteristics of the web.

The coform web may also possess filtration characteristics enhanced by an electret additive blended with the polymer. The electret additive may be barium titanate and malic anhydride, for example about 1% by weight of barium titanate and about 5% by weight of malic anhydride. In an alternative embodiment, the electret

additive is an ionomer polymer and may also include barium titanate. For example, the ionomer polymer may be about 20% to about 50% by weight of the polymer blend and the barium titanate about 1% by weight of the polymer blend.

A face mask filtration media in accordance with the present invention has shown to possess a significantly reduced pressure drop (translating to a face mask having greatly improved breathability) while having an equal filtration efficiency as compared to a conventional meltblown polypropylene web typically utilized in face mask applications.

BRIEF DESCRIPTION OF THE FIGURES

Fig. 1 is a perspective view of one style of conventional face mask applicable to the present invention; and

Fig. 2 is a front and partial cut-away view of the conventional mask of Fig. 1 illustrating various structural components of such face masks.

DETAILED DESCRIPTION

Reference will now be made in detail to embodiments and examples of the invention. Each example is provided by way of explanation of the invention, and not as a limitation of the invention. For example, features illustrated or described as part of one embodiment can be used with another embodiment to yield a still further embodiment. It is intended that the present invention include modifications and variations not particularly described herein.

As used herein, any given range is intended to include any and all lesser included ranges. For example, a range of from 45-90 would also include 50-90; 45-80; 46-89; and the like.

The present invention relates generally to a face mask incorporating an improved filtration media. An exemplary face mask structure is illustrated in Figs. 1 and 2. The mask 10 includes a pleated body 12 defined between an upper edge 36, a lower edge 34, and sides 32. Tie straps 16 and 18, or any other suitable means or

devices are provided for securing the mask 10 over the nose and mouth of the wearer 14. The body 12 is formed by a plurality of layers. Typically, face masks include an inner layer 30 and an outer layer 22. The inner and outer layers can be formed of various materials known to those skilled in the art. Any number of additional layers, for example a barrier layer 26, may also be included. At least one intermediate layer is typically provided in the form of a filtration media layer 28. The focus of this invention is on the filtration media layer.

It should be appreciated that the present invention is not limited to any particular type or style of face mask, and that the pleated style mask of Fig. 1 is shown for illustrative purposes only. The filtration media according to this invention may be incorporated into any face mask style or configuration. Exemplary faces masks are described and shown, for example, in the following U.S. patents: 4,802,473; 4,969,457; 5,322,061; 5,383,450; 5,553,608; 5,020,533; and 5,813,398. These patents are incorporated herein in their entirety for all purposes.

The filtration media according to the invention is comprised of a nonwoven web (for example a meltblown web) of polymer fibers having a multiplicity of individual pulp fibers disposed throughout the matrix of polymer fibers. The pulp fibers engage at least some of the polymer fibers and hold the polymer fibers apart thereby increasing the permeability of the filtration web. As discussed in greater detail below, the polymer may also include an electret additive to increase the filtration efficiency of the overall web.

As used herein, the term "nonwoven" web refers to a structure of individual fibers or filaments which are interlaid, but not in an identifiable repeating manner as in a knitted fabric. Nonwoven webs can be formed by a variety of processes known to those skilled in the art, such as meltblowing, spunbonding, and bonded carded web processes.

As used herein, the term "polymer" generally includes, but is not limited to, homopolymers, copolymers, such as block, graft, random, and alternating copolymers, terpolymers, etc. and blends and modifications thereof. Furthermore, unless otherwise specifically limited, the term "polymer" shall include all possible geometric configurations of the material.

As used herein, the term "meltblown fibers" refers to fibers formed by extruding a molten polymer material through a plurality of fine, usually circular, die capillaries as molten threads or filaments into a high velocity gas (e.g. air) stream which attenuates the filaments of molten polymer material to reduce their diameters, which may be to microfiber (not greater than 100 microns) diameter. Thereafter, the meltblown fibers are carried by the high velocity gas stream and are deposited on a collecting surface to form a web of randomly disbursed meltblown fibers. The meltblown process is well-known and is described in various publications, including NRL Report 4364, "Manufacture of Super-Fine Organic Fibers" by V. A. Wendt, E. L. Boone, and C. D. Fluharty; NRL Report 5265, "An Improved Device for the Formation of Super-Fine Thermoplastic Fibers" by K.D. Lawrence, R. T. Lukas, and J. A. Young; and U.S. Pat. No. 3,849,241.

As used herein, the term "pulp" refers to pulp containing fibers from natural sources such as woody and non-woody plants. Woody plants include, for example, deciduous and coniferous trees. Non-woody plants include, for example, cotton, flax, esparto grass, milkweed, straw, jute hemp, and bagasse.

Frazier Porosity is a standard measure in the non-woven web art of the permeability of the material (units in cubic feet per square foot per minute). The procedure used to determine Frazier air permeability is in accordance with the specifications of method 5450, Federal Test Methods Standard No. 191.

Filtration efficiencies of nonwoven webs may be evaluated using a TSI Inc. (St. Paul, Minn.) Model 8110 Automated Filter Tester (AFT).

The Model 8110 AFT measures pressure drop (in mm. of water) and particle filtration characteristics for air filtration media. The AFT utilizes a compressed air nebulizer to generate a filter "challenge" aerosol of sodium chloride particles. Typical air flow rates are between 31 liters per minute and 33 liters per minute through a sample area of the filter medium. The filtration efficiency is expressed as the percentage of sodium chloride particles which penetrate the filter. Penetration is defined as transmission of a particle through the filter medium which are detected downstream of the medium. The percent penetration (%P) reflects the ratio of the downstream particle count to the upstream particle count. Filtration efficiency (E) may be calculated from the percent penetration by the following: E=100-%P

The pulp/polymer fiber web may be formed in a continuous on-line "coforming" process. The resulting webs are often referred to as "coform" webs. U.S. Pat. No. 4,100,324 describes a process and apparatus for making such webs, which are described as having a unique combination of strength, absorbency, and hand. The '324 patent is incorporated herein in its entirety for all purposes. U.S. Pat. No. 5,350,624 likewise describes a coforming process that is particularly suited for manufacturing the filtration web according to the present invention. The '624 patent is also incorporated herein in its entirety for all purposes.

The pulp/polymer coform web exhibits and increased porosity (reduced pressure drop) due primarily to the entanglement of the pulp and polymer fibers. The material is formed by initially forming a primary airstream containing the meltblown fibers and forming a secondary airstream containing the pulp fibers. The two airstreams are merged under turbulent conditions to form an integrated airstream containing a homogenous mixture of the pulp and meltblown fibers. The integrated airstream is directed onto a forming surface to form the coform web. Because the polymer fibers are longer, thinner, and more flexible than the pulp fibers, they twist around and entangle the

relatively short, thick, and stiffer pulp fibers as soon as the two fiber streams merge in the forming process. The entanglement interconnects the two different types of fibers with strong, persistent inter-fiber attachments without any significant molecular, adhesive, or hydrogen bonds. The polymer fibers are spaced apart by engagement with the relatively stiff pulp fibers and, thus, the resulting coform web retains a high degree of porosity.

The invention is not limited to a particular polymeric material. Polymers suitable for this invention can be selected from any fiber-forming polymer. Representative polymers include polyolefin, e.g. polypropylene, polyethylene, polymethylpentente, polyester, and polyurethane. Meltblown polyolefin fibers have proven well suited for face mask filter media applications, particularly polypropylene based fibers. Although the invention is described herein as a meltblown polypropylene fiber web, it should be appreciated, however, that a number of suitable polymers or polymer blends are known in the art and can be used to form the polymer fiber component of the present coform web.

The pulp content of the filtration web according to the invention ranges from about 2% to about 50% by weight of the web, and particularly between about 15% to about 35%. As described in the illustrative Example herein, an optimum amount of about 25% pulp content has demonstrated significantly improved breathability (pressure drop) with equivalent filtration properties as compared to a meltblown web without a pulp fiber component.

The filtration coform media according to the invention may also preferably include an electret additive package added to the molten polymer to increase the filtration characteristics of the resulting meltblown web. The electret additive package may be in accordance with U.S. Pat. No. 5,780,153 (incorporated herein). In this embodiment, the additive package is an ionomer resin blended with the polyolefin (e.g. polypropylene) in the fiber extruder. The ionomer

additive package may be added in a range of from about 20% to about 59% by weight of the polymer blend. In an alternate embodiment, barium titanate is also added to the blend in an amount of about 1% by weight.

An alternative electret additive that has proven useful is a package of 1% barium titanate and 5% malic anhydride olefin copolymer.

The present filtration coform media is not limited in its basis weight. Various basis weight coforms may be utilized depending on the particular desired face mask configuration. Generally the basis weight ranges from about 5 gsm (grams per square meter) to about 50 gsm. A particularly well suited coform may have a basis weight of about 25 gsm.

The following Example serves to further describe the filtration media according to the invention:

EXAMPLE

A polymer/pulp coform was made in accordance with the present invention. The coform had a total basis weight of 25 gsm (20 gsm meltblown polypropylene (PF-015) and 5 gsm of softwood pulp). The coform was made substantially in accordance with U.S. Pat. No. 5,350,624. A comparative example was also made consisting of a 20 gsm meltblown polypropylene web. The coform was tested against the comparative example for filtration efficiency and pressure drop using the Automated Filter Tester (AFT) described above. The coform had a 31% lower pressure drop and essentially equal filtration efficiency as compared to the meltblown comparative example.

WHAT IS CLAIMED IS:

1. A face mask, said face mask comprising:

a body configured to fit over the nose and mouth of the wearer;

said body further comprising at least one layer of filter media disposed between an inner layer and an outer layer;

said filter media comprising a polymer/pulp coform web formed of a matrix of polymer fibers with individual pulp fibers disposed throughout , said pulp fibers engaging and holding said polymer fibers apart;

wherein said coform web comprises about 2% to about 50% by weight of said pulp fibers; and

wherein said coform web has a basis weight of about 5 gsm to about 50 gsm.

2. The face mask as in claim 1, wherein said coform web comprises about 25% by weight of said pulp fibers.

3. The face mask as in claim 2, wherein said coform web has a basis weight of about 25 gsm.

4. The face mask as in claim 1 wherein said polymer fibers comprise polypropylene.

5. The face mask as in claim 1, wherein said polymer fibers are meltblown from a polymer blend having an electret additive to improve electret characteristics of the polymer fibers.

6. The face mask as in claim 5, wherein said polymer is polypropylene and said electret additive is barium titanate and malic anhydride.

7. The face mask as in claim 6, wherein said barium titanate is about 1% by weight of said polymer blend and said malic anhydride is about 5% by weight of said polymer blend.

8. The face mask as in claim 5, wherein said polymer is polypropylene and said electret additive is an ionomer polymer and barium titanate.

9. The face mask as in claim 8, wherein said ionomer polymer is about 20% to about 50% by weight of said polymer blend and said barium titanate is about 1% by weight of said polymer blend.

10. A face mask, said face mask comprising:

a body configured to fit over the nose and mouth of the wearer;

said body further comprising at least one layer of filter media disposed between and inner layer and an outer layer;

said filter media comprising a meltblown polymer/pulp coform web formed of a matrix of meltblown polypropylene fibers with individual pulp fibers disposed throughout , said pulp fibers engaging and holding said polymer fibers apart;

said meltblown polypropylene fibers formed from a polymer blend having an electret additive to improve electret characteristics of the polymer fibers;

wherein said coform web comprises about 25% by weight of said pulp fibers; and

wherein said coform web has a basis weight of about 25 gsm.

11. A face mask filtration media, comprising:

a meltblown polymer/pulp coform web formed of a matrix of meltblown polymer fibers with individual pulp fibers disposed throughout , said pulp fibers engaging and holding said polymer fibers apart;

wherein said coform web comprises about 2% to about 50% by weight of said pulp fibers; and

wherein said coform web has a basis weight of about 5 gsm to about 50 gsm.

12. The face mask filtration media as in claim 11, wherein said coform web comprises about 25% by weight of said pulp fibers.

13. The face mask filtration media as in claim 12, wherein said coform web has a basis weight of about 25 gsm.

14. The face mask filtration media as in claim 11, wherein said polymer fibers comprise polypropylene.

15. The face mask filtration media as in claim 11, wherein said meltblown polymer fibers are formed from a polymer blend having an electret additive to improve electret characteristics of the polymer fibers.

16. The face mask filtration media as in claim 15, wherein said polymer is polypropylene and said electret additive is barium titanate and malic anhydride.

17. The face mask as in claim 16, wherein said barium titanate is about 1% by weight of said polymer blend and said malic anhydride is about 5% by weight of said polymer blend.

18. The face mask as in claim 15, wherein said polymer is polypropylene and said electret additive is an ionomer polymer and barium titanate.

19. The face mask as in claim 18, wherein said ionomer polymer is about 20% to about 50% by weight of said polymer blend and said barium titanate is about 1% by weight of said polymer blend.

20. A face mask filtration media, comprising:

a meltblown polymer/pulp coform web formed of a matrix of meltblown polypropylene fibers with individual pulp fibers disposed throughout , said pulp fibers engaging and holding said polymer fibers apart;

said meltblown polypropylene fibers formed from a polymer blend having an electret additive to improve electret characteristics of the polymer fibers;

wherein said coform web comprises about 25% by weight of said pulp fibers; and

wherein said coform web has a basis weight of about 25 gsm.

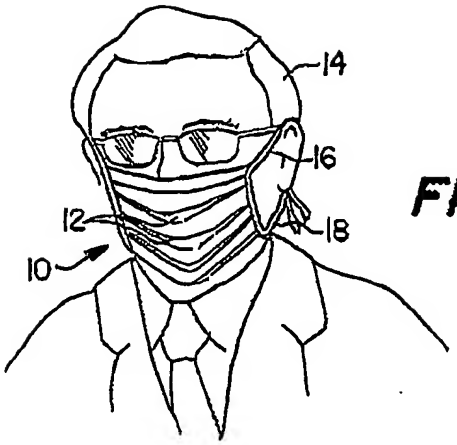

FIG. 1

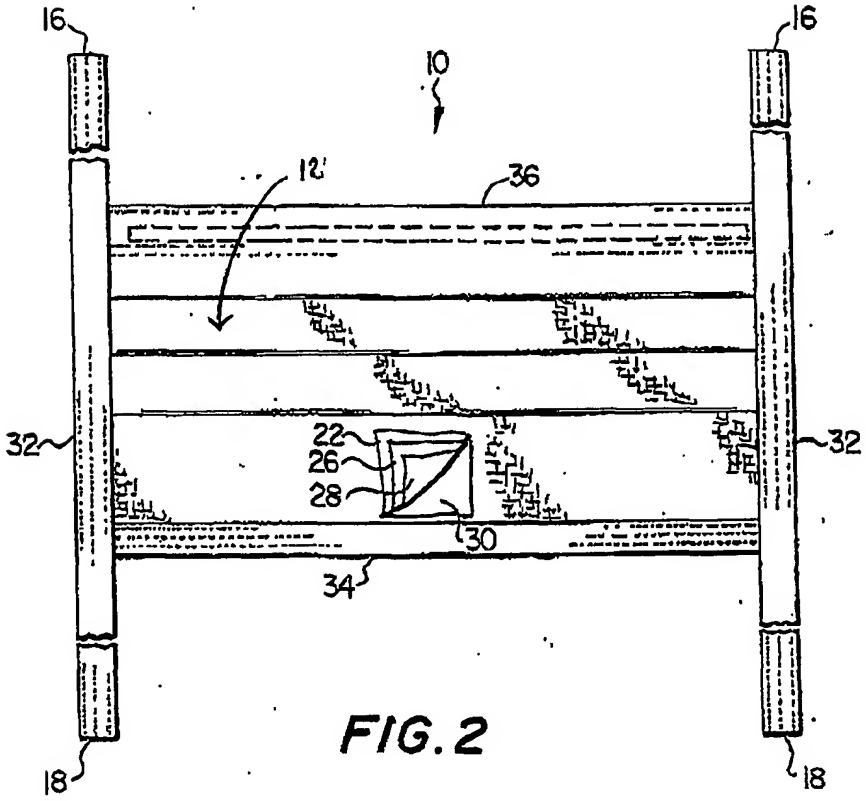

FIG. 2

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(74) Agent: **VICK, John, E., Jr**; Dority & Manning, P.A., One Liberty Square, 55 Beattie Place, Suite 1600, Greenville, SC 29602 (US).

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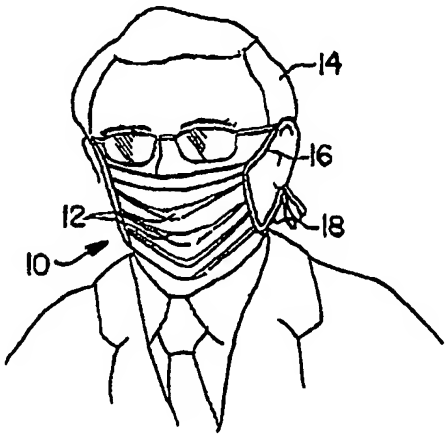

(57) Abstract: An improved face mask filtration media includes a meltblown polymer/pulp coform web formed of a matrix of meltblown polypropylene fibers with individual pulp fibers disposed throughout. The meltblown polypropylene fibers may be formed from a polymer blend having an electret additive to improve electret filtering characteristics of the polymer fibers. The invention also contemplates any style or configuration of face mask utilizing the improved filtration media.

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INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A41D13/11

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A41D B01D D04H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 784 892 A (STOREY DENNIS G ET AL) 15 November 1988 (1988-11-15) column 3, line 57 -column 4, line 21; figures; table	1-20
A	WO 98 53896 A (KIMBERLY CLARK CO) 3 December 1998 (1998-12-03) page 9, line 1-18; table	1,10,11, 20
A	US 5 658 641 A (OLSON DAVID A ET AL) 19 August 1997 (1997-08-19) figure 1	1-20
A	EP 0 391 725 A (JOHNSON & JOHNSON MEDICAL) 10 October 1990 (1990-10-10) the whole document	1-20

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[X] Further documents are listed in the continuation of box C. [X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
27 August 2002	06/09/2002

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Barathe, R

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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